Low-cost electrochemical sensing of CO, NO, NO2, and O3 : vertical differences in atmospheric composition between 3m and 20m in wintertime Fairbanks (Alaska)

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Résumé

During winter, local emissions (e.g. from vehicules, home-heating) can be trapped by temperature inversions, leading to episodes of high surface pollution in urban Arctic environments such as Fairbanks, Alaska. Monitoring of atmospheric composition is challenging in the cold Arctic. Here, a method using low-cost electrochemical sensors is developed for the measurement of CO, NO, NO2, and O3 at cold temperatures down to -30C.

The sensors were characterised by cross-comparison to reference monitors in Fairbanks. Analysis algorithms were developed to correct for temperature variations and cross-sensitivities, yielding gas abundances in strong agreement to reference data (R2 > 0.83-0.98, MAE< 5 ppbv (NO, NO2, O3) and 50 ppbv (CO) over ranges of 10's-100's, and 3000 ppbv, respectively).

During four weeks in February-March 2021, the sensors were deployed at two heights (20m and 3m) on the roof and base of a Fairbanks building. At night, CO and NOx abundances were more elevated at the surface than aloft, demonstrating that pollution was partially trapped by inversions below 20m. Ozone was depleted by NOx at the surface, whilst ozone was either fully or partially depleted at 20 m aloft. During the day, the abundances of CO, NO, NO2 and O3 measured at 3m and 20 m converged, reflecting disruption of inversions and vertical mixing. The measured NO, NO2 and Ozone and Ox (O3+NO2) are consistent with O3-NO-NO2 atmospheric chemistry. The observations indicate a large direct emission of NO2 as a source of Ox, with NO2:NOx of 0.13 mol/mol, of relevance to understanding atmospheric oxidation in Fairbanks wintertime.

When well-characterised with appropriate analysis algorithms, low-cost electrochemical sensors can provide valuable observations of atmospheric composition including continuous monitoring of the vertical distribution of pollutants and oxidant gases in cold urban boundary

*Intervenant

layer environments. Further applications on rooftops and vertical profiling are ongoing in the CASPA-ALPACA projects.

Mots-Clés: microcapteur, low, cost, sensor, electrochemical, urban, inversion, Arctique, Arctic